

THE CLIMATOLOGY OF THE VINE (*VITIS VINIFERA* L.) [3] A COMPARISON OF FRANCE AND AUSTRALIA ON THE BASIS OF THE TEMPERATURE OF THE WARMEST MONTH

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[Read 10 April 1969]

SUMMARY

The history of climatological investigations on the requirements of the vine in France has been outlined. In order to bring this experience into a wider field of use, it is shown that the temperature of the warmest month can be used as a simple index. This temperature can be expected on mathematical grounds to be a linear function of the sums of temperatures that have been extensively used in the past. This expectation is confirmed by an examination of data for the northern limit of cultivation in Europe, for California in general, and for the classical work of Angot (1885). A brief example is given of the application of this principle to the choice of varieties for any given environment.

INTRODUCTION

In a previous communication (1969) a comparison was made, on a climatic basis, between the viticultural areas of Australia and their homoclimes in the Mediterranean region. In this comparison, based essentially on the temperature characteristics of annual mean and amplitude, only a small area of France, restricted to the Mediterranean littoral of that country was shown to afford anything approaching a strict parallel to any of the Australian conditions. French experience is so long and so well documented that it is important to find some simple climatic criterion that would extend the application of this experience to a wider geographical range. The most widely used criterion has been the sums of temperatures expressed as day-degrees over a specific group of months, usually the seven months: April to October, or over a specified growth period, such as flowering to maturity. This concept was originally established by de Candolle (1855) where a minimum of 2,900 day-degrees (centigrade) above a limiting temperature of 10° C. was required. The development of this concept in France was principally due to de Gasparin (*Cours d'Agriculture* vol. 4, 1860) who classified vine varieties into seven groups according to their degree of earliness and who established the "quantities of heat" necessary for the maturation of the grapes in each class. De Gasparin, however, based the maximum temperatures used in the derivation of the mean on the black-bulb thermometer exposed to the sun, so that they cannot be readily interpreted today, and it was Angot (1885) who later pointed out the appropriateness of using shade temperatures.

The study of the climatic limits of viticulture in France has a long history. Arthur Young (1792), in what became edited later as "Travels in France", included a map entitled "a new map of the climate and navigation² of France", in which the northern limits of cultivation of vines, maize and olives were shown by straight lines having a north-easterly trend. In the absence of temperature data, these limiting lines were to be regarded as climatic indicators. In a verbal description of the limit for vines Young wrote³ "the line of separation between vines and

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² By "navigation" Young meant the navigability of rivers.

³ *loc. cit.* p. 298.

no vines, as I observed myself is at Coucy, ten miles to the north of Soissons; at Clermont, in the Beauvoisis; at Beaumont in Maine; and Herbignac, near Guerande in Bretagne". He suggested that it would be reasonable to extend this line into Germany as far north as latitude 52° .¹

By the second decade of the nineteenth century, a sufficient number of temperature observations over an adequate geographical range had been accumulated to justify the concept and definition of *isotherms* by Humboldt (1817). Although Humboldt did not produce any maps, he provided an extensive table of data from which the trends of isotherms could be judged and, in some cases maps prepared. In this publication Humboldt referred briefly to the possible application of his concepts to agriculture, taking into account not only the annual isotherms, but also the associated mean summer and winter temperatures for any given locality, including specifically the temperatures of the warmest and coldest months. With respect to the cultivation of the vine in Europe he noted that, providing summer temperatures reached 19° C. or 20° C., cultivation could be extended up to a latitude of 50° N. Later in his *Kosmos* (1845) he was able to give, as a special example, the temperature limits of the vine when cultivated to produce potable wine. These were defined as a mean annual temperature of not less than 9.5° C., a mean winter temperature of at least 0.5° C. and a mean summer temperature of at least 18° C. This mean summer temperature was based on the months of June, July and August, corresponding in modern observations to 17.9° C. and for the warmest month to 18.7° C.

In 1880, the Central Bureau of Meteorology in Paris organised for the first time, the regular observations of vegetation phenomena in France, and at the same time arranged for the collection of such historical information regarding the viticultural seasons and the declaration of vintages (*Ban de vendanges*) as could be derived from municipal and other records. This information was in due course analysed by Alfred Angot (1885), and provided a valuable and unique historical document on climatic conditions in France. The earliest period of vintage recorded was that for 1366 at Dijon and by extending the records to those of Wurtemberg, the quantity and quality of the vintage was established for some years as far back as 1236, while for Burgundy these records began in 1689.

The *ban de vendange* was originally established as a feudal manorial right. This right was abolished in principle in 1791, but was retained as a communal responsibility from that date, in order to guarantee the quality of the best vintages. Long records of the date of the declaration of vintage are to be found in many municipalities and communes and the longest such is for Dijon and goes back with full continuity to 1572.

Of importance to the present study is that Angot was able to correlate the mean period of vintage over a period of 20 years (1860-1879) with temperature observations over the same period, for 22 sets of observations covering mean annual temperatures ranging from 9.0° C. at Gap (Hautes-Alpes) to 15.0° C. at Perpignan (Roussillon). The annual march of temperature was expressed in each case in terms of the constants of a Fourier series (*formule périodique*) where the first two terms of the series proved to be adequate. The commencement of vegetation was assumed to coincide with the time at which mean temperature reached 9° C. and this was calculated from the formula as well as the sums of temperatures between this date and that of the declaration of vintage. For convenience in discussion, these data were placed in seven groups ranging in sums of temperature above 9° C. from 973 to 1957 day-degrees.

¹ John Evelyn in his diary for 1643-44 had earlier observed the north-western limits of the cultivation of the vine at Beauvais and Pontoise.

It is of further interest that Angot was able, by eliminating very early table varieties and very late varieties, and by regrouping, to reduce an original classification of de Gasparin from seven to two groups. These were made up of an early group of varieties able to ripen in the vicinity of Paris and a later group not able to do so. Of interest to Australian vignerons typical varieties in the first group included *Pinot noir*, *Sémillon* and *Shiraz* and the second group included *Malbec*, *Carignan* and *Grenache*.

The assessment of current views and practices has been facilitated by a series of reports commissioned by the *Office international de la vigne et du vin* and presented to the appropriate Commission in September 1967. These reports deal with methods and principles adopted in various countries in determining regional requirements for the culture of the vine and for the choice of varieties. The reports have been published in the *Bulletin of the International Office* (1967, 1968). In these reports table grapes and wine grapes receive equal emphasis. In some respects, because of the need to cater for markets over as long a period as is practicable, the climatic requirements of table grapes provide a wider range of conditions than do wine grapes, and in most cases the variety *Golden Chasselas* is used as a standard of reference with respect to period of maturity. The earliest table grapes generally include the Hungarian variety *Perle de Csaba* and a number of strains of *Madeleine*. The lists of the latest table varieties usually include the variety *Ohanez*.

The climatic requirements are dealt with in a variety of ways, but practically always the sums of temperatures are used over a fixed period, usually the seven months from April to October, although for Bordeaux, Ribéreau-Gayon and Peynaud (1960) quote the period April to September. These sums are sometimes quoted as above 0° C. and also as "efficient" temperatures above 10° C. In other cases the sums are calculated from the time of bud-burst to that of technical maturity.

The extremes are illustrated by the German report in which only the mean temperature from April to October is quoted, and by the Tunisian report, in which the sums of temperature are calculated as degree-hours over the months March to December. The Israeli report quotes sums of "active" temperatures, that is above 10° C. from bud-burst to maturity over periods varying from 100 days for early varieties to 135 days for very late varieties with the sums ranging from 950 to 1,900 day-degrees, which is very close to the original range of Angot.

Of specific interest to the present study, Brejoux and Daverne in the French report recognise two principal climatic types for that country, namely the Atlantic and Mediterranean, with a semi-continental bridge between the two along the valleys of the Rhine, the Saône and the Rhône.

The relationship between sums of temperature and the temperature of the warmest month

The annual temperature curve of the monthly means for localities within the latitudes determining the limits of the cultivation of *Vitis vinifera* is sufficiently close to a smooth trigonometric curve to suggest that some of the simple properties of such a curve could reasonably be found to be valid. This was early recognised by Angot, as has been mentioned above, and the wave-form characteristics of annual mean, amplitude and phase have frequently been used by the author in climatic studies.

The early recommendation by Humboldt that summer temperatures could be used to establish the geographically cool limit of the vine was statistically confirmed by the author (Prescott, 1965). In terms of the temperature of the warmest month, in both cases this proved to be 18.7° C. Owing to the deciduous

nature of the vine and its winter dormancy, the temperature of the coldest month becomes significant only when damage through frost becomes important.

For a simple cosine curve of temperature, any area beneath the curve, limited by a fixed temperature and within specified time limits can be readily shown to be a linear function of the maximum temperature. Where the critical temperature is one-half of the temperature of the warmest month, there is in fact a strict proportionality between day-degrees and that temperature. For a number of stations along the northern limit of the cultivation of the vine in Europe, the length of the season above 10°C . approximates to 6 months and such a correlation could, in fact, be expected if only approximately. For perfect agreement, the periods for comparison should have the same phase.

In order to illustrate this relationship, three examples have been taken. One example, provided by the data of Angot, previously mentioned, for the period 1860-1879 in which sums of temperatures are calculated from the temperature curves between the time when the temperature first reaches 9°C . and the time of the mean declaration of vintage for these areas. From the wave-form constants quoted by Angot for the temperature curves, it is readily possible to calculate the mean temperature of the warmest month in each case. Angot found it convenient to group his 22 sets of observations into seven and these have been plotted in Fig. 1. It will be seen that an almost perfect rectilinear correlation exists between the pairs of values.

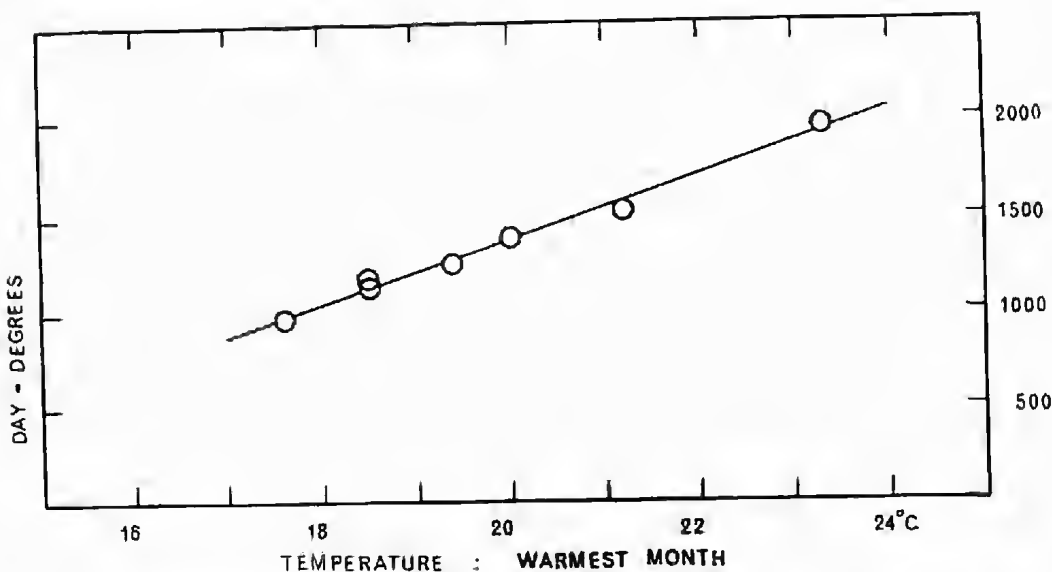


Fig. 1. Illustrating the relationship between the sums of temperature over 9°C . and the temperature of the warmest month. The limits chosen are from the time when the mean daily temperature reaches 9°C ., to the time of the average beginning of vintage for groups of French viticultural areas. The data are those of Angot (1885) for the period 1860-1879. The temperatures of the warmest month are derived from estimates of the annual mean plus amplitude based on the Fourier constants given by Angot.

Californian and European experience is drawn upon for the data illustrated in Fig. 2. The Californian data are taken from official records of stations chosen for their viticultural importance. The concept of sums of temperatures has been extensively used by viticultural workers in California, for example, Winkler

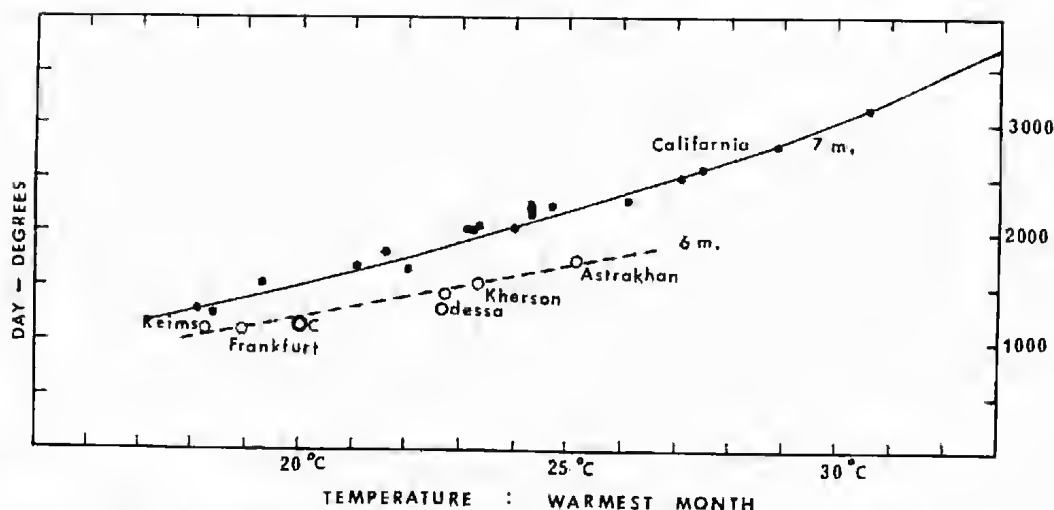


Fig. 2. Illustrating the relationship between the sums of temperatures over 10° C. and the temperature of the warmest month for California and Europe. The California data are based on the months April to October in accordance with current practice. The European data are for the cool limit of cultivation of the vine, using selected stations with season of approximately six months with mean temperatures above 10° C. The circle C represents the theoretical value for a cosine curve (20° C., 1162 day-degrees).

(1962), with particular reference to the subdivision and definition of the viticultural areas of that State into five regions based on temperature summation. The European data are for the cool limit of cultivation as established by the author (1965). In both cases a satisfactory relationship is shown to exist. In the case of the Californian data, the line connecting the pairs of values shows a slight curve.

It should therefore be possible to use the temperature of the warmest month as a substitute for sums of temperatures for general comparisons. The correlation is only valid for mean values over a period of years and cannot be expected to hold for individual seasons. On this basis, however, maps have been prepared for south-eastern Australia and for France, on which the isotherms for the warmest months are shown. This is illustrated in Figs. 3 and 4. The following Table 1 gives a wider perspective to the comparison.

TABLE 1
Temperature of the warmest month for viticultural areas

European and Mediterranean localities	°C	Australian localities
Cool limit of cultivation	19	Geelong (Vic.) Coonawarra (S. Aust.)
Bordeaux (France)	20	
	21	Stawell (Vic.)
	22	Clare (S. Aust.)
Montpellier (France)	23	Rutherglen (Vic.) Berri (S. Aust.)
	24	Griffith (N.S.W.)
	25	Mildura (Vic.)
Tunis (Tunisia)	26	
Izmir (Turkey)	27	
	28	Roma (Qld.)
El Fayum (Egypt)	29	
Jordan Valley (Israel)	32	

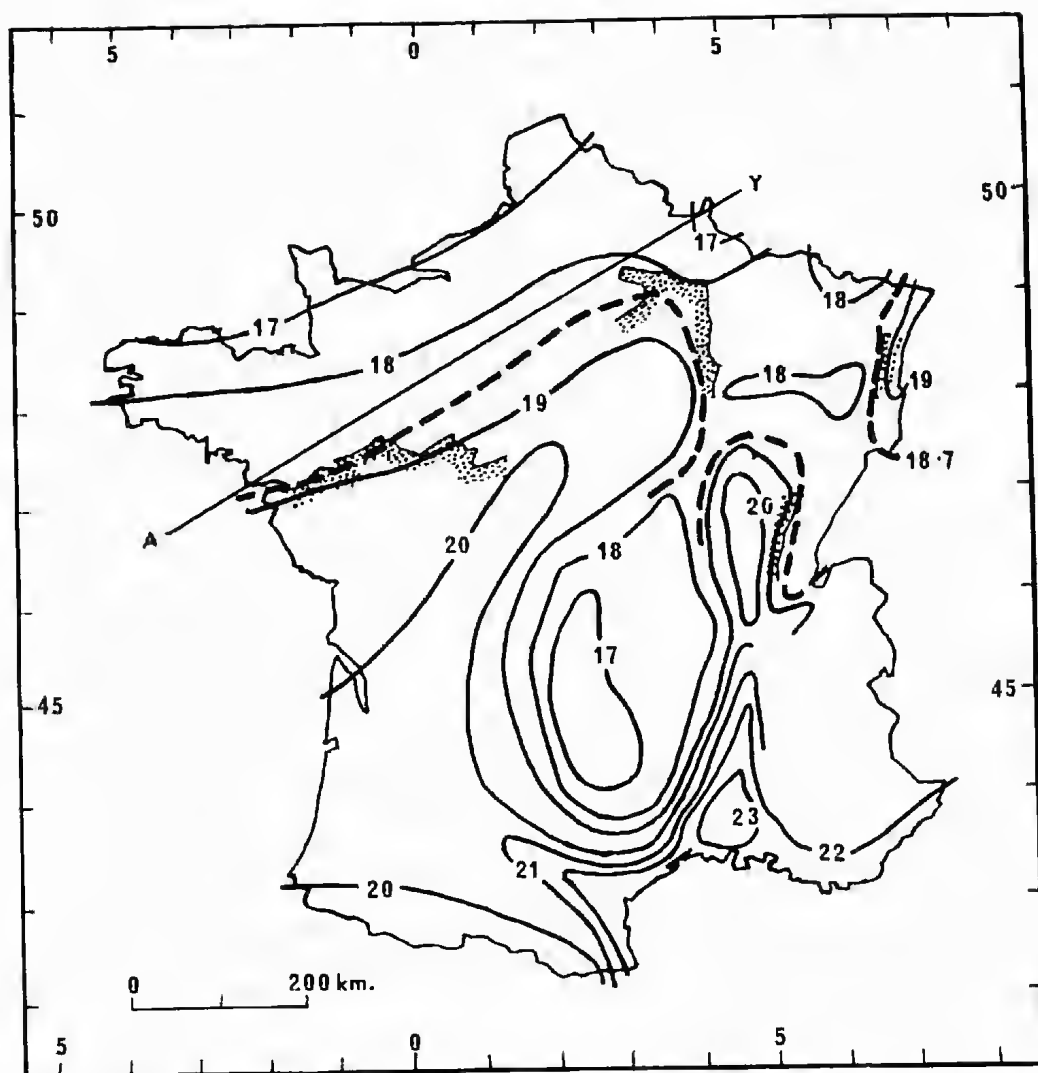


Fig. 3. Map of France with isotherms of the mean temperatures of the warmest month in relation to viticulture. The isotherm for 18.7°C . is based on the cool limit of cultivation in western Europe. The line AY gives the limit recognised by Arthur Young (1792). The stippled margins represent the cool limits of areas recognised for quality by the *Institut national des appellations d'origine* on the map of 1949.

Probably the best example of the use that can be made of the comparison between France and Australia would be in the selection of varieties for any given locality and temperature conditions. It is not intended to present an exhaustive list—this is a task for the experienced viticulturist, but the list in Table 2 may be suggestive in this regard. It will be recalled that Angot divided varieties into two groups, one of which would ripen in the vicinity of Paris and the other not so. The present list may be regarded as an extension of such a concept.

With respect to table grapes, the variety *Chasselas*, which is the most important in France, affords an example of the problems involved in climatological interpretation for such a variety.

TABLE 2

Cool limits for a selection of varieties of vines based on French experience

Temperature of the warmest month °C	Variety
18 — 19	<i>Chardonnay</i> <i>Chenin</i> <i>Gamay</i> <i>Pinot noir</i> <i>Riesling</i> <i>Traminer</i>
19 — 20	<i>Cabernet gros</i> <i>Cabernet sauvignon</i> <i>Malbec</i>
20 — 21	<i>Syrah (Shiraz)</i> <i>Sémillon</i>
21 — 22	<i>Trebbiano (Ugni blanc)</i> <i>Muscat of Alexandria</i>
22 — 23	(<i>Muscat gordo blanco</i>) <i>Carignan</i> <i>Cinsaut</i> <i>Grenache</i> <i>Mataro (Mourvèdre)</i>

Chasselas first appears in the Paris market in early July from the coastal region of Algeria. This is followed by the crop from the Mediterranean coast of southern France. The main supply comes in late August and in September from the country of the Garonne, with superior quality from near Moissac. Very late supplies come from the region of Paris.

This variety is also used as a wine grape in the semi-continental regions of France and is a recommended variety for certain areas in the Franche-Comté and for Alsace. Under the synonym *Gutedel* it is also used in Germany for wine making. In Baden-Wurtemberg, this variety is grown to the extent of 8.5 percent of the viticultural area.

Constantinescu in the Romanian report points out that certain early varieties do not produce grapes of high quality when grown under warm conditions.

ACKNOWLEDGEMENTS

It is a pleasure to record the help received from the Library of the Royal Society in London in securing copies of the papers by Humboldt and Angot. Thanks are due to Mr. K. M. Cellier and Prof. J. R. Prescott for discussions on the mathematical problems involved and particularly to the late Mr. J. C. M. Fornachon, as director of The Australian Wine Research Institute, for his continued interest in the investigation.

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Bulletin de l'O.I.V.

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Romania	Constantinescu, G.	40/441	1967	1179-1205
France	Brejoux, P. and Daverne, P.	40/442	1967	1315-1333
South Africa	Beukman, E. F.	41/443	1968	19-27
Switzerland	anon.	41/443	1968	28-37
Tunis	Taoufik, B. A.	41/444	1968	135-158
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Bulgaria	Nedeltchev, N.	41/448	1968	651-657
Luxembourg	Faber, J.	41/448	1968	657-664
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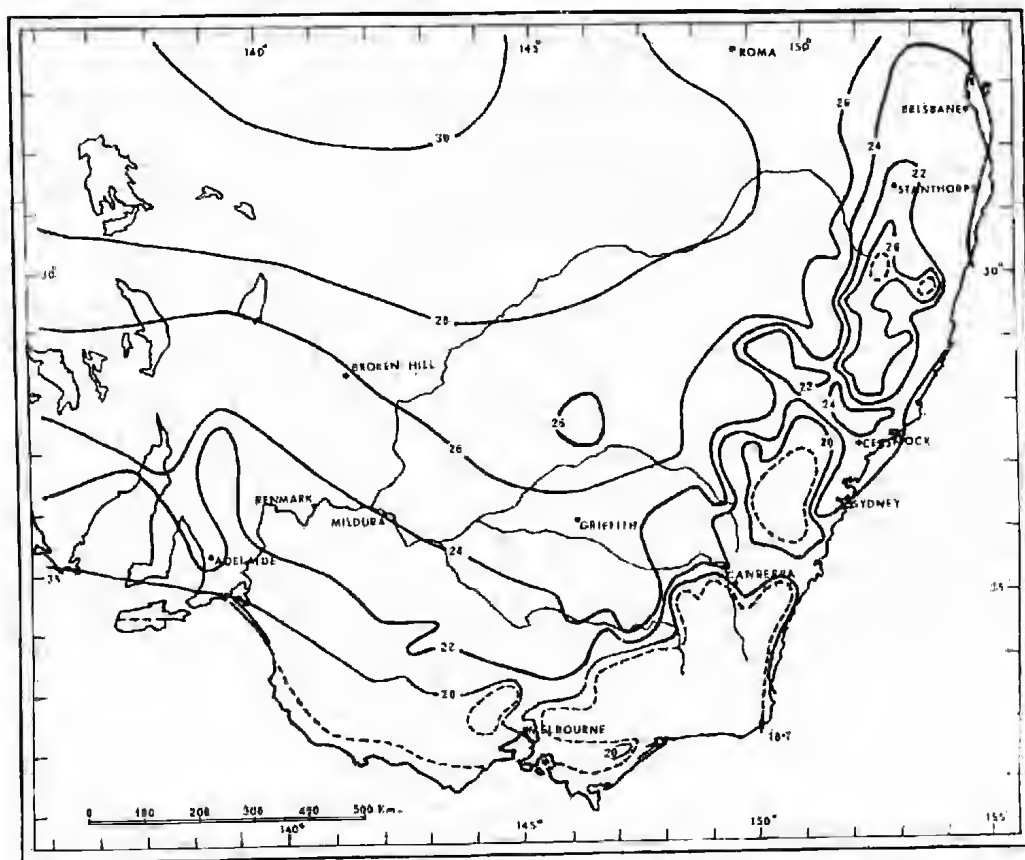


Fig. 4. Map of south-eastern Australia with isotherms of the mean temperatures of the warmest month in relation to viticulture. The isotherm for 18.7° C., represented by a broken line, is based on the cool limit of cultivation of the vine in western Europe.

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